Signals and Rituals of Humans and Animals

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<TXT> Ritual is a universal feature of human behavior. While rituals differ from culture to culture, the defining features that distinguish them from “ordinary” behaviors are surprisingly consistent across all human societies. Rituals tend to be formal, stereotyped, repetitive, and “traditional”. They are therefore easily distinguished from other behaviors. Rituals help pattern and predict social interactions. For example, when two people meet they have expectations about how the social interaction will proceed. In Western societies, meetings commence with a handshake and a simultaneous “How are you?” or some similar formality. While none of us invented the handshake, we all recognize it as a greeting ritual.

Religious rituals are particularly easy to detect as they tend to be more elaborate than other rituals. They also generally include music, chanting, or dance, which further distinguishes them from other behaviors. Masks, icons, special settings, extraordinary garments, and even distinctive languages may be used to further demarcate religious ritual from the ordinary. While religious rituals frequently appear to be shrouded in mystery, their formality and elaborateness make it clear to participants and observers alike that they are rituals. Nobody mistakes Sunday morning church for the Sunday afternoon football game.

The same underlying features of ritual that allow us to recognize it across widely diverse human cultures also enable us to recognize ritual in nonhuman species. Wild dogs, wolves, and chimpanzees all perform highly ritualized greeting ceremonies that include muzzle-to-muzzle contact, hugging, and choral vocalizations whenever the members of a social group meet. Wolf spiders, salamanders, and Sandhill cranes all perform intricate dances as part of their courtship. Parrots and Pacific humpback whales engage in improvisational, synchronized singing during mating and group rituals. Chimpanzees have been observed to engage in occasional "drumming" of tree trunks and sporadic group "rain dances". Ritual conveys significant social information about participants in both human and animal groups. It permits and promotes social interaction by creating "frameworks of expectancy" that lay the foundation for the prediction of behavior by others. But to fully appreciate the similarities between human and animal rituals, and to understand why they are similar, we first need to understand ritual's less complicated parent: signals.

<H1> Signals as Cooperative Communication

<TXT> We all use signals in everyday life. Colored lights that regulate traffic flow and sirens that alert us to possible danger are examples of common human visual and auditory signals. Animals, too, use many different kinds of signals to communicate with other members of their groups. The scent marking of dogs, the alarm calls of monkeys, and the changing colors of Siamese fighting fish are all signals that convey information about the state, condition, or intent of the sender. Some signals, such as the croak pitch of male frogs, directly convey the physical and physiological characteristics of the sender. Since croak pitch is a function of body size, larger males produce deeper croaks. This direct relationship between body size and sound pitch makes it possible for both females and competitor males to estimate the size of unseen males based solely on their croaking. Such "indexical" signals convey reliable information about a signal sender because they are directly linked to attributes that cannot be concealed or manipulated by the sender.

Most signals used in human and animal communication are not indexical, but still provide reliable information about the sender. They have evolved over time because they benefit both the sender and the receiver. Numerous conventional signals, such as the pecking response of herring-gull chicks to red dots, are the result of genetically programmed fixed-action patterns. Such signals automatically elicit or "release" evolved preprogrammed behaviors in signal receivers. In the case of the herring chicks, pecking at the red dots on the mother's bill provides the chick with food. Grouper fish exhibit innate responses to the “dance” performed by sucker fish. Even when reared in isolation, groupers exposed to the sucker fish dance lie down on the sand, spread their fins, and allow the sucker fish to clean the algae from their scales. Such genetically encoded fixed-action pattern signaling systems have evolved because the benefits they provide for both the sender and receiver outweigh the costs involved in signaling.

Although it was once thought that all animal signals result from these genetically programmed “fixed-action patterns,” ethologists have since found that many animal signals are much more complex, incorporating both genetic and learned components. The alarm calls of vervet monkeys (*Cercopithecus aethiops*) provide a good example of such complex signals. Vervets inhabit woodland areas in eastern Africa and use alarm calls to alert other members of the social troop to the presence of predators. Vervets emit a bark in the presence of a jaguar, a cough in the presence of an eagle, and a chutter in the presence of a snake. Young vervets have an innate tendency to respond to calls and to make different calls in response to different stimuli. However, young monkeys are not born with preprogrammed knowledge of jaguar, eagle, and snake calls. They must learn the specific call to emit for each particular predator. While vervets are “preprogrammed” to learn these calls, young monkeys must hear the different calls used within the appropriate context in order to learn the correct call for each particular predator.

This innate capacity to learn species-specific signals during a particular developmental period is seen in many other species. The courtship songs of many birds involve both genetic programming and developmental learning; male birds are genetically “primed” to learn their species’ song but must be exposed to it during a specific developmental window in order for learning to occur. In humans both music and language learning integrate this same combination of genetic predispositions and culturally-transmitted learning during specific developmental periods.

<H1> Signals as Deception

<TXT> Sometimes signaling contexts involve senders and receivers who have conflicting interests. Under such circumstances, there is great incentive for signalers to

use deception in order to influence receiver responses. Camouflage, mimicry, and deception are widespread throughout the animal kingdom. Many species have evolved color patterns and special structures to deceive potential predators and prey. Viceroy butterflies fool potential predators through their mimicry of the unappetizing Monarch. Angler fish lure unsuspecting prey with a specially-evolved mouth appendage. Females of the predatory firefly genus *Photuris* mimic the mating flashes of the related genus *Photinus* in order to lure *Photinus* males close enough to attack and consume them. Humans bluff, cheat, and lie in cards, war, and love.

<H1> Honest Signals

<TXT> Signal receivers clearly have an incentive to detect dishonest signals and prevent such manipulation. Receivers should seek out signals that provide honest information. In many species this has resulted in the evolution of "quality signals" that provide receivers with reliable information about the general condition of the sender. In birds the intensity of plumage color is negatively correlated with parasite load—the brighter the plumage, the healthier the bird. Females seek out males with the most brilliant plumage. As a result, the color brilliance of males has evolved to be a quality signal for females. In humans, a similar quality signal is provided by facial symmetry, which is positively correlated with health. Numerous studies have shown that males and females worldwide find symmetrical faces more attractive. In various songbird species, male song repertoire size is an important quality signal for females. Males with large song repertoires are less likely to be infected by malarial parasites and more likely to bring larger caches of food for their offspring.

Quality signals that benefit the receiver frequently incur costs for the sender. Male peacocks with the longest, brightest tails and male songbirds with the largest repertoires not only expend more energy on the development and maintenance of these traits, they also attract more predators than less showy individuals. Biologist Amotz Zahavi has proposed that such high cost signals are adaptive for signalers precisely *because* they "handicap" the sender. Since only those peacocks and songbirds with sufficient resources are able to successfully produce and maintain the longest, showiest tails and the largest and most captivating song repertoires, it would be impossible for less fit competitors to "fake" these signals. Likewise, Mazeratis and mega-mansions constitute culturally-constructed quality signals in contemporary human societies, since only the wealthiest can afford the direct, maintenance, and opportunity costs of such luxuries.

<H1> Ritual as a Signal

Rituals are the costliest of signals. The four basic elements of ritual -- formality, pattern, sequence, and repetition -- incur high time, energy, and resource costs for ritual performers. Yet, these four features make up the structure of ritual in species as diverse as horned-toads, hens, and humans. Laboratory experiments have shown that these elements of ritual are optimally effective in engaging and focusing attention, heightening discrimination, enhancing multidimensional generalization, and improving associative learning. The formality of ritual captures the attention of the audience and focuses it on the signal elements most likely to evoke receiver response. Ordinary traits and behaviors may be exaggerated in order to make them "extraordinary." The "eyes" of a peacock's long, iridescent tail prominently displayed during his ritual dance, the changing body colors of male squid as they gently jet water over a potential mate, and the ornate garments worn by human brides all represent formal elements of ritual that engage and focus the attention of ritual participants.

By exaggerating and elaborating ordinary features, the formality of ritual alerts brain structures such as the reticular formation, the basal ganglia, and the amygdala that function to prime emotions and prepare the body to react. Once attention is focused, the sequence, pattern, and repetition of ritual optimize the processing time critical for memory and learning.

Ritual has other impacts on neuroendocrine function, as well. Changes in levels of neurotransmitters, neuromodulators, and hormones of both the sender and the receiver occur during ritual, resulting in changes in the physiological, immunological, and behavioral responses of ritual participants. Biologist Russell Fernald's studies of cichlid fish (*Haplochromis burtoni*) from Lake Tanganyika in Africa dramatically illustrate ritual's effects on physiology. He found that agonistic displays between cichlid males induce major changes in the hormones, external appearance, brain neuron sizes, and even the gene expression of winners and losers. Fernald observed aggressive and brilliantly colored black, yellow, blue, and red males almost instantly morph into much less aggressive drab brown "satellite" fish when ousted from their territories by rivals. If the "satellite" later acquired a new territory, his color, hormones, hypothalamic neuron sizes, and gene expression again changed. Similar neuroendocrine changes have been recorded in songbird responses to ritual, as well. The ritualized vocalizations of male songbirds impact female sexual receptivity by inducing hormonal changes in the female, but they also impact the brain neurons and song-related genes of the signaler. In wolves and nonhuman primates, ritualized dominance and submission behaviors can alter participants' cortisol, dopamine, and testosterone levels. Across animal species, the ability of ritual to alter individual neurophysiology and behavior is critical to its adaptive value.

<H1> The Relationship of Human and Animal Signaling Systems

Many human signaling systems share deep phylogenetic roots with our closest primate kin. Like bonobos and chimpanzees, humans everywhere use similar facial expressions to identify and convey basic emotional states. Likewise, laughter, body language, and shouts of alarm are universally understood within both chimp and human societies. Yet, the most elaborate and distinctive human rituals, including synchronized chanting, music, and dance, are notably rare in other primates. While our distant cousins, the pair-bonded gibbons, do engage in male-female "singing" duets, the ritualized use of collective song and dance is conspicuously absent among all of our closest kin, including gorillas, bonobos, and chimpanzees.

Collective song and dance are, however, found in many other animal species. Wolves and wild dogs engage in choral howling, humpback whales sing synchronized group songs, and a multitude of bird species chorus, sing, and dance. Across human and non-human species alike, such ritualized behaviors evoke emotional and physiological responses that impact individual health and behavior while defining, facilitating and patterning social interaction. Understanding the nature and function of animal ritual not only broadens our understanding of non-human species, it also deepens our understanding of ourselves.

<SA> ***See also*** **Music, Dance, and Theater—***Music and Animals*

Music, Dance, and Theater—*Music as a Shared Trait among Humans and Animals*

<RH> Further Resources

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